BOUTRON BOUDET SOAP SOLUTION

By A. M. Buswell[1]

From time to time the writer has heard the question raised as to the strength of the Boutron Boudet or "B and B" soap solution and the original description of its use. Since this solution is extensively employed at the present time in specifying a water of "zero hardness," it seems worth while to give briefly its history.

Charlard Boutron and Felix Boudet (1) published an article in 1855 "Concerning hydrotimetry or a new method of analyzing water from springs and rivers." "Hydrotimetry" the authors explain is a new word which they have coined from the three Greek words "Υδαγ, τιμή, μέτρον" meaning a measure of the value of water. The process is essentially similar to the soap test for hardness previously described by Clark (2), with whose work Boutron and Boudet seem not to have been familiar. (From the reference it will be noted that Clark first described the soap test in his patent application of 1841 and that it was described in the Chemical Gazette by him in 1847 and abstracted in the Jahresbericht in 1850).

The authors describe their methods as follows:

> The formation of the foam on the surface of the water is moreover a phenomenon so striking, the proportion of soap necessary to produce it (1 decigram per liter) is so slight, and the moment when a calcareous or *magneseous* water ceases to neutralize soap and becomes foamy, is so easy to perceive, that a solution of soap may be considered an extremely sensitive reagent for detecting and determining the calcareous and *magneseous* salts in very dilute liquors such as spring and river waters.
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> We employ the soap dissolved in alcohol and to avoid the errors which necessarily result from the variable composition of soap, we titrate our solution against a standard solution of fused calcium chloride containing 25 centigrams of the salt per liter of distilled water, i.e., 1 to 4000. The test is carried out in a flask of 60 to 80 cubic centimeters capacity with a ground stopper and marked at 40 cubic centimeters; and a small buret graduated in such a manner that:
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> First, A division marked above the zero represents the amount of soap solution necessary to form a lather with 40 cubic centimeters of pure water.

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Second, That each division below the zero degree represents 1 decigram of mottled soap of 30 to the hundred (30 per cent) of water and 6 to the hundred (6 per cent) of soda, destroyed by one liter of water subjected to the experiment and thus a water which absorbs for example 10° of the solution destroys or neutralizes 1 gram of soap per liter.

Third, Finally, that 22° corresponds exactly to 40 cubic centimeters or 40 grams of the standard solution of calcium chloride of 25 centigrams per liter.

As a result of this system the graduation of the buret indicates directly the proportion of soap destroyed by a liter of the water examined and the calcium chloride equivalent of the calcium and magnesium salts which are contained in a liter of said water. Nothing is more easy than to find out by rapid test the equivalent in calcium chloride of the salts of calcium and magnesium which waters contain and to establish their relative value by comparing the degrees which they give with the test buret. We have given this instrument the name hydrotimetre, which is to say, measure of the value of water. Our system of testing constitutes then hydrotimetry and one may classify waters according to their hydrotimetrique degrees starting from pure water which carries zero degrees.

The unit upon which the authors started out to found their method is apparently 1 decigram of "mottled soap" which is the amount required in their experiments to produce a foam with 1 liter of pure water, but realizing the variability in composition of soap they checked their soap solution against the standard $CaCl_2$ solution mentioned and the latter therefore became the real standard. Though not as clearly stated as it might be it is evident from the context that the division above the zero mark on the hydrotimeter buret has the same volume as those below, namely sufficient to hold soap solution "representing 1 decigram of mottled soap . . . . destroyed by one liter of the water tested." The standard unit is, therefore, the amount of soap required to give a lather with 40 cc. of pure water which happens to be $\frac{1}{23}$ of that required to give a lather with 40 cc. of a solution of $CaCl_2$ containing 0.25 gm. per liter.

The authors' description unfortunately defines only the $CaCl_2$ solution leaving the reader to make his own adjustment of the strength of the soap solution and the length of the buret graduations, though, of course, one depends upon the other. Zune (3) quoting Levy (4), states that the soap solution was made by dissolving 100 grams of dry almond oil soap in 1600 grams of 90 per cent alcohol and diluting with 1000 of pure water. Levy, however, used a method of standardization and calculation whereby an ordinary buret is used instead of the one described by Boutron and Boudet.

Several of the well recognized limitations of the soap test in general are cited in the same article. De la Coux (5) described what is apparently the original "hydrotimetre" which is shown in the accompanying figure. With this buret the same soap solution as that described by Levy is used. It will be seen from the figure that 2.4 cc. = 23 buret divisions. The first division, it must be remembered, measures the amount of soap required for 40 cc. of pure water. This author recommends $Ba(NO_3)_2$, instead of $CaCl_2$ for the standard

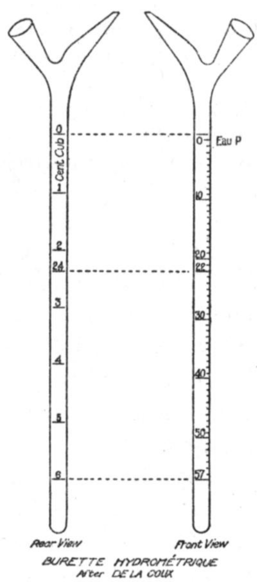

FIG. 1.

and gives 0.59 gm. per liter as the amount of $Ba(NO_3)_2$ equivalent to 0.25 gm. of $CaCl_2$.

Walter and Gärtner (6) state that the Boutron Boudet hydrotimetrique degree is the same as the French degree or one part of $CaCO_3$ per 100,000. This, however, is not the case by about 2.2 per cent. Walter and Gärtner, however, use 0.574 gm. $Ba(NO_3)_2$ per liter for their standard solution instead of 0.59, which is equivalent to the original 0.25 gm. $CaCl_2$.

Booth (7) describes the French method giving the strength of the soap solution, but not the dimensions for the buret. Booth uses the word *normal* in referring to the $CaCl_2$ and $Ba(NO_3)_2$ solutions

in the sense of *standard*, instead of in the modern colloquial chemical sense (i.e., chemical equivalents per liter).

The Boutron Boudet soap solution is then a solution of 100 grams of pure soap in about 2500 cc. of 56 per cent alcohol by volume and adjusted so that 2.4 cc. will give a lather with 40 cc. of a solution of $Ba(NO_3)_2$ containing 0.59 gm. per liter. Or, if we accept Walter and Gärtner's suggestion to make it read in "French degrees," we must use 0.574 gms $Ba(NO_3)_2$ per liter. On the basis of the relative amounts of soap used, the Boutron Boudet solution is approximately 4 to 5 times as strong as that specified by the standard methods of the A.P.H.A. Owing to the wide difference in technique, it is difficult to make a more definite comparison. Assuming that 2.4 cc. of the B and B solution equals 22 French degrees or 220 p.p.m. on a 40 cc. sample, 3.0 cc. would be required for 50 cc. We see from the table on P. 32 of Standard Methods that a solution of such a hardness would require 4.65 cc. of standard soap when diluted one to four. This comparison makes the B and B solution about six times as strong as that of standard methods. It would be about three and one-half times as strong as the solution formerly used in some laboratories, which read 1 cc. per French degree on a 100 cc. sample.

The Boutron and Boudet soap solution has a very practical value in demonstrating to the layman the value of water softening. The original unit, the amount of soap required to give a lather with pure water is something that any one can understand. It is also easily apparent that a water of 5 or 10 degrees hydrotimetrique has 5 or 10 times the soap demand of pure water.

The solution also serves a useful purpose in the hands of the non-technical owner of a zeolite water softener. He measures the performance of his machine in drops of solution, which he can understand, rather than in cubic centimeters, a unit of which he has never heard.

BIBLIOGRAPHY

(1) Boutron, Charlard et Boudet, Felix: De l'hydrotimetrique ou nouvelle methode d'analyse des eaux de sources et de rivieres. Compte Rend., **40**, 1855, p. 679.

(2) Clark, Th.: Repertory of patent inventions for 1841. A new process for purifying the water supplied to the metropolis. London, 1849.

Clark, Th.: On the examination of water for towns for its hardness. Chem. Gaz., **5**, 100, 1847. Reviewed in detail by J. Moser, Wien. Acad. Ber., 1850, April, 484; Abstract, Jahresbericht, **3**, 608, 1850.

(3) ZUNE: Traite d'Analyse des Eau Potables. Imprimerie A. Lefevre, Bruxelles, 1894.
(4) LEVY: Annuaire de l'Observatoire Municipal de Montsouris, Paris, 1892.
(5) DE LA COUX: L'Eaux dans l'Industrie, Paris, 1900.
(6) WALTER AND GÄRTNER: Tiemann-Gärtners Handbuch der Untersuchung der Wasser, 4th Ed., 1895.
(7) BOOTH: Water softening and treatment. Van Nostrand & Co., 1906.